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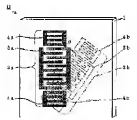
(54) **SURFACE ACOUSTIC WAVE DEVICE**



(57)Abstract:

PROBLEM TO BE SOLVED: To secure both frequency and filter characteristics as desired and to improve the line width accuracy of a comb-like electrode by

setting the electrode finger directions of the comb-like electrode in non-parallel to each other on both sides and accordingly reducing the difference of center frequency between the surface acoustic wave(SAW) devices.
SOLUTION: When an SAW device 2b is produced, the 2nd exposure ultraviolet rays are reflected and scattered on an IDT electrode 3a of an SAW device 2a that is first produced. This reflecting/scattering direction is vertical to the electrode finger directions of the electrode 3a. If the directions of electrode fingers of both devices 2a and 2b are overlapping each other, for example, the rays reflected and scattered by the electrode 3a are made incident in the line width directions of fingers of an IDT electrode 3b and therefore directly affect the line widths of the electrode digitals. In this respect, the directions of electrode fingers are set in non-parallel to each other forming an angle θ between the directions. As a result, the intensity of the ultraviolet rays incident in the line width directions of the fingers of the electrode 3b are reduced according to an angle θ and accordingly the line width accuracy is not easily deteriorated. Thus, the difference of center frequency can be reduced between both devices 2a and 2b.

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* NOTICES *

CLAIMS

[Claim(s)]

[Claim 1] Surface acoustic wave equipment characterized by the direction of an electrode finger of the ctenidium-like electrode which is surface acoustic wave equipment which it comes to prepare in front flesh-side both sides of one piezo-electric substrate respectively, and formed in said table flesh-side both sides the surface acoustic element which has the ctenidium-like electrode of the pair constituted so that two or more parallel electrode fingers might be engaged by turns not being mutually parallel.

[Claim 2] Surface acoustic wave equipment according to claim 1 whose angle theta which the direction of an electrode finger of the ctenidium-like electrode of said table flesh-side both sides makes is 30 degrees <= theta<=150 degrees.

[Claim 3] Surface acoustic wave equipment according to claim 2 which said piezo-electric substrate consists of a lithium tantalate single crystal, and is 36.3 degrees <= theta<=143.7 degrees.

[Claim 4] Surface acoustic wave equipment according to claim 1 to 3 on which

the insulating or semi-conductive protective coat of 500A or less of thickness is put all over front flesh-side both sides of said piezo-electric substrate.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the surface acoustic wave equipment used for mobile communication equipment, such as a cellular phone, for example, the surface acoustic wave equipment of a dual mode.

[0002]

[Description of the Prior Art] Surface acoustic wave (by Surface Acoustic Wave, it abbreviates to SAW hereafter) equipment D1 of the conventional dual mode An example is shown in drawing 4 . This drawing (a) is SAW equipment D1. A perspective view and (b) are the sectional views in the A-A line of (a).

[0003] In this drawing, two SAW components 12a and 12b from which frequency characteristics, such as a passband property, differ in both the principal planes (front flesh-side both sides) of the piezo-electric substrate 10 are formed. The reflectors 14a, 14a, 14b, and 14b for these SAW components 12a and 12b

having the ctenidium-like electrodes (henceforth [it is Inter DigitalTransducer and] an IDT electrode) 13a and 13b of a pair at least respectively, reflecting SAW in the both ends of the SAW propagation path of the IDT electrodes 13a and 13b depending on the case, and making it resonate efficiently are formed (refer to JP,2-218209,A).

[0004] Moreover, there are some which prepared two SAW components from which frequency characteristics differ in one principal plane of the piezo-electric substrate 10 as SAW equipment of a dual mode.

[0005] Although various signal processing systems are used for mobile communication equipment, such as a cellular phone and a digital cordless telephone, in recent years, development of the concomitant use machine which can be equivalent to two kinds of signal processing systems at coincidence is becoming active. Therefore, the request to the SAW equipment of a dual mode which can be equivalent to two different signal processing systems, such as above center frequency, pass band width, etc., is becoming large.

[0006]

[Problem(s) to be Solved by the Invention] however -- although the IDT electrodes 13a and 13b are formed in the front rear face of the above-mentioned piezo-electric substrate 10 -- a case -- each SAW equipment D1 In between, there was a trouble that center frequency tends to shift. It is considered to be based on the following causes.

[0007] Namely, although IDT electrode 25 formation process which consists of a photolithography process, a vacuum deposition process, a lift-off process, etc. is respectively given by a unit of 1 time to the front rear face of the piezo-electric substrate 21 as shown in drawing 5 In the photolithography process of the 2nd IDT electrode 25 formation process The ultraviolet rays 23 for the exposure for carrying out patterning of the resist film 22 through a photo mask 24 It is reflected and scattered about with the IDT electrode 25 of the SAW component formed first, the line breadth precision of patterning of the IDT electrode 25 formed in the 2nd time falls, and it is based on the reason center frequency shifts from a design

value as a result.

[0008] Moreover, although two kinds of SAW components could also be put in order and installed in one principal plane of a piezo-electric substrate, in the contiguity section of these SAW(s) component, it needed to be used separately, consequently it reflected, light was scattered [the ultraviolet rays for exposure interfered, or] about from coincidence, the pattern [finishing / the next formation], or the electrode finger in two kinds of photo masks by the photolithography process, and the line breadth precision of patterning was falling. The effect was larger as these SAW components approached.

[0009] Therefore, it is in this invention being completed in view of the above-mentioned situation, and making small a gap of the center frequency between each SAW equipment in the SAW equipment which the purpose forms two sorts of SAW components in the front rear face of a piezo-electric substrate, and changes, and desired uniform frequency characteristics and a filter shape being obtained, and enabling formation of the line breadth precision of an IDT electrode with high precision.

[0010]

[Means for Solving the Problem] The surface acoustic wave equipment of this invention the surface acoustic element which has the ctenidium-like electrode of the pair constituted so that two or more parallel electrode fingers might be engaged by turns It is characterized by the direction of an electrode finger of the ctenidium-like electrode which is surface acoustic wave equipment and was formed in said table flesh-side both sides which it comes to prepare in front flesh-side both sides of one piezo-electric substrate respectively not being mutually parallel. By such configuration A gap of the center frequency of each surface acoustic wave equipment is made small, and desired uniform frequency characteristics and a filter shape are obtained, and formation of the line breadth precision of a ctenidium-like electrode is attained with high precision. In this invention, the angle theta which the direction of an electrode finger of the ctenidium-like electrode of said table flesh-side both sides makes is 30 degrees

<= theta<=150 degrees preferably. Moreover, preferably, said piezo-electric substrate consists of a lithium tantalate single crystal, and is 36.3 degrees <= theta<=143.7 degrees.

[0011] Furthermore, preferably, all over front flesh-side both sides of said piezo-electric substrate, the insulating or semi-conductive protective coat of 500A or less of thickness is put, and a resistance to environment improves and discharge arises between the electrode fingers of a ctenidium-like electrode further in the pyroelectric effect of the piezo-electric substrate by the elevated temperature at the time of heat treatment, and a ctenidium-like electrode can short-circuit, or, thereby, it can control and prevent being damaged.

[0012]

[Embodiment of the Invention] This invention is explained using drawing 1 - drawing 3 . Drawing 1 is the perspective view of the basic configuration of the SAW equipment D of this invention. One piezo-electric substrate with which 1 consists of a lithium tantalate (LiTaO3) single crystal of 36 degreeY cut-X propagation etc. in this drawing, 2a, two SAW components with which 2b was prepared in front flesh-side both sides (both principal planes) of the piezo-electric substrate 1, respectively, The IDT electrode of the ctenidium-like electrode of the pair constituted so that 3a and 3b might engage two or more parallel electrode fingers by turns, the reflector with which 4a and 4a were prepared in the both ends of the propagation path of SAW of IDT electrode 3a, and 4b and 4b are the reflectors prepared in the both ends of the propagation path of SAW of IDT electrode 3b. As for such SAW component 2a and 2b, each direction of an electrode finger of the IDT electrodes 3a and 3b is mutually made un-parallel.

[0013] Thus, if the direction of an electrode finger is made un-parallel, it will be thought that a gap of center frequency becomes small according to the following operations.

[0014] That is, although IDT electrode 3of SAW component 2a produced to the 1st time a reflects and the 2nd ultraviolet radiation for exposure is scattered about by it in case the 2nd SAW component (for example, SAW component 2b)

is produced, the main directions of the reflection and dispersion are presumed to be a perpendicular direction to the direction of an electrode finger of IDT electrode 3a (longitudinal direction of an electrode finger). For example, the direction of an electrode finger is parallel, and when SAW component 2a and 2b have lapped mostly, the reflected light and the scattered light by IDT electrode 3a carry out incidence in the line breadth direction of the electrode finger of IDT electrode 3b, and affect the line breadth of a direct electrode finger. Then, if the direction of an electrode finger is made un-parallel, according to the angle theta to make, the reinforcement of the ultraviolet radiation which carries out incidence in the line breadth direction of the electrode finger of IDT electrode 3b decreases, line breadth precision will stop being able to deteriorate easily and, as a result, a gap of center frequency will be considered to become small.

[0015] Drawing 2 shows other operation gestalten of this invention, and is the perspective view of the basic configuration of SAW equipment Da. The piezo-electric substrate with which 10 consists of a lithium tantalate (LiTaO3) single crystal of 36 degreeY cut-X propagation etc. in this drawing, Two SAW components with which 20a and 20b were prepared in front flesh-side both sides of the piezo-electric substrate 1, respectively, An IDT electrode, the reflector with which 30a and 30b were prepared in 40a, and 40a was prepared in the both ends of the propagation path of SAW of IDT electrode 30a, and 40b and 40b are the reflectors prepared in the both ends of the propagation path of SAW of IDT electrode 30b. As for these SAW components 20a and 20b, the electrode finger of the IDT electrodes 30a and 30b is aslant formed to the bus bar.

[0016] Generally, since SAW is perpendicularly spread to an electrode finger, if the tilt angle of the electrode finger to a bus bar is too large, the propagation path of SAW will shift from the electrode finger of an IDT electrode 30a edge. Therefore, the tilt angle to a bus bar is a maximum of about 30 degrees, and when it is larger than 30 degrees, the expected property as a resonator and a filter is difficult to get [a tilt angle].

[0017] Therefore, angle thetaa which the direction of an electrode finger of SAW

component 20a and the direction of an electrode finger of SAW component 20b make is good to consider as 0 degree<thetaa<=60 degree. About 5 degree<thetaa<=45 degree is good more preferably. If larger [when smaller than 5 degrees, the effectiveness of this invention is difficult to get, and] than 45 degrees, the resonance effectiveness of SAW will fall and loss will tend to increase.

[0018] and two or more drawing 3 is the graphs which produced, expressed the gap of the center frequency of those passbands with 3sigma (sigma: standard deviation) of an axis of ordinate, and set the axis of abscissa to theta every about the SAW equipment D to which the angle theta which uses a piezo-electric substrate as the lithium tantalate single crystal of 36 degreeY cut-X propagation about the thing of drawing 1 , and the direction of an electrode finger makes was variously looked like [equipment], and was changed. As shown in this drawing, 3sigma (sigma: standard deviation) is [theta] small rapidly bordering on about 30 degrees, theta is about 150 degrees or less similarly, and 3sigma becomes small rapidly. Therefore, 30 degrees <= theta<=150 degrees are suitable.

[0019] Furthermore, generally, when a piezo-electric substrate is the lithium tantalate single crystal of 36 degreeY cut-X propagation, since the inclination field of **4MHz and a passband edge is 4MHz, it is good [spacing of a passband and a rejection band region / the shift amount of the passband edge by 20MHz and the temperature change (operational temperature range: -30 degrees C - 80 degrees C)] to suppress dispersion in center frequency below to 20-4x2-4=8MHz. Therefore, in drawing 2 , it became clear that the field where dispersion in center frequency becomes below 8MHz was 36.3 degrees <= theta<=143.7 degrees.

[0020] Although SAW component 2a of this invention and 2b may be the so-called SAW filters of the filter with which frequency characteristics, such as center frequency and pass band width, differ, respectively, and a dual mode, even if they are the thing of the same frequency characteristics, they are not cared about. Moreover, two or more same SAW components as one principal plane may be prepared, for example, ladder mold SAW filters, such as a 2.5 step

pi mold, a 2.5 step T mold, and a three-step mold, may be constituted.
[0021] When the SAW equipment D of this invention is the SAW filter of the above-mentioned dual mode, SAW component 2a and IDT electrode 3a of 2b differ in an electrode finger pitch and electrode digital-furrow width of face from IDT electrode 3b, respectively, and Reflectors 4a and 4a differ from Reflectors 4b and 4b similarly. Such IDT electrode 3a, IDT electrode 3b, Reflectors 4a and 4a, and Reflectors 4b and 4b are formed of a process including the removal process of the unnecessary resist by the film formation process of the electric conduction film by the resist spreading process of a positive type (type which dissolves by exposure), or a negative mold (type which does not dissolve by exposure), a photolithography process, the vacuum deposition method, the sputtering method, the CVD method, the applying method, etc., the lift-off method, the etching method, etc. and the unnecessary electric conduction film.
[0022] For example, it is produced by following process (1) - (6).
[0023] (1) Wash the piezo-electric substrate 1 of the lithium tantalate single crystal of the 36 degreeY cut-X propagation which ground the front face, apply a resist to the one principal plane (front face) by about 1.0-micrometer thickness, and make it dry at 90 degrees C.
[0024] (2) Use the photo mask which forms electrode line breadth, such as IDT electrode 3a, by about 1 micrometer, and they are the wavelength of about 225nm, and output 25.2 mW/cm2. Ultraviolet radiation performs adhesion exposure for about 4 seconds, and it is made to dry at 110 degrees C, and it is immersed in a developer, negatives are developed for 90 seconds, and a rinse is carried out with pure water.
[0025] (3) Form aluminum for IDT electrode 3a and reflector 4a, and 4a with vacuum evaporation technique, and carry out lift off of the unnecessary section of aluminum to a resist with resist exfoliation liquid.
[0026] (4) Apply a resist to the principal plane (rear face) of another side of the piezo-electric substrate 1 by about 0.5-micrometer thickness, and make it dry at 90 degrees C.

[0027] (5) Use the photo mask which forms electrode line breadth, such as IDT electrode 3b, by about 0.5 micrometers, and they are the wavelength of about 225nm, and output 25.2 mW/cm2. Ultraviolet radiation performs adhesion exposure for about 1.5 seconds, and it is made to dry at 110 degrees C, and it is immersed in a developer, negatives are developed for 90 seconds, and a rinse is carried out with pure water.

[0028] (6) Form aluminum for IDT electrode 3b and reflector 4b, and 4b with vacuum evaporation technique, and carry out lift off of the unnecessary section of aluminum to a resist with resist exfoliation liquid.

[0029] Thus, SAW component 2b with a line breadth [of the electrode finger of IDT electrode 3b] of 0.5 micrometers is formed in the front-face side of the piezo-electric substrate 1 at a with a line breadth [of the electrode finger of IDT electrode 3a] of 1 micrometer SAW component 2a and rear-face side.

[0030] In this invention, it is desirable to put a protective coat 500A or less all over front flesh-side both sides of the piezo-electric substrate 1 in which SAW component 2a which uses abundantly the IDT electrodes 3a and 3b by which thinning was carried out, and 2b were formed. By preparing a protective coat, effectiveness like the following (1) - (4) is acquired.

[0031] (1) Conventionally, although the resist turned pattern NINGU up and membranes were formed so that a protective coat might be formed for example, except for a pad electrode, and the unnecessary part was removed by the following **** etch method or the lift off method, at the time of the developer immersion in this pattern NINGU process, aluminum alloys for pad electrodes (an aluminum-Cu system, an aluminum-Ti system, aluminum-Si system, etc.) are etch with a developer, and prevent having cause degradation of frequency characteristics, and the fall of dependability.

[0032] (2) Prevent that aluminum of a pad electrode began to melt into water according to the local battery effectiveness, and degradation of frequency characteristics and the fall of dependability had arisen at the time of the pure-water rinse after the development in said pattern NINGU process.

[0033] (3) In case the wafer for piezo-electric substrate 1 is cut by the dicing method, aluminum begins to melt by contacting the pad electrode with which cooling water is not covered by the protective coat, and it can prevent the adhesion reinforcement of wire bond having fallen.

[0034] (4) According to the pyroelectric effect of the piezo-electric substrate 1, discharge arises between the electrode fingers of the IDT electrodes 3a and 3b and Reflectors 4a, 4a, 4b, and 4b at the time of heat treatment of the desiccation process after resist spreading in a pattern NINGU process, a wire-bonding process, a packaging process, etc., and control and prevent at it that an electrode finger is damaged.

[0035] Said protective coats are insulating things, such as SiO2, SiO, Cr-SiO2, Cr-SiO, and SiN, or the semi-conductive (half-conductivity) thing whose resistance of the direction of the film (direction parallel to the film) is about 109-1013ohms, and are the oxide of Si, Ta, Mo, germanium, NiCr, NiCr-Si, and Ta or a nitride, the oxide of Mo or a nitride, the oxide of germanium, or a nitride. 109 Between electrode fingers becomes easy to short-circuit under by omega, and the counteraction of a charge falls in 1013-ohm **. Said semi-conductive protective coat can reduce the incidence rate of discharge to about 30% - about 50% as compared with an insulating thing. This is because a semi-conductive protective coat tends to ease the density-of-electric-charge difference between electrode fingers. Moreover, the electric resistance in a pad electrode becomes small, and degradation of a filter shape is smaller than an insulating thing. Such a protective coat is formed by the thin film forming methods, such as well-known vacuum deposition, the sputtering method, and a CVD method.

[0036] It becomes difficult for the thickness of a protective coat to carry out direct bonding of the wire to a pad electrode, if 500A or less is good and exceeds 500A, consequently the adhesion reinforcement of the wire after bonding falls. Moreover, the electric resistance of a bonding area becomes large and frequency characteristics, such as a filter shape, deteriorate. More preferably, 25-500A is good and the effectiveness as a protective coat is almost lost by less than 25A.

[0037] Moreover, in one principal plane of the piezo-electric substrate 1, it is more desirable to form the electric conduction film for the SAW component of a piece, a circuit pattern, and the pad electrodes for external derivation in 25% or more of the area of said one principal plane at least. By this configuration, the area of the electric conduction film with the early rate which captures the charge which floated in air becomes large, and neutralizes the charge on the electric conduction film and the piezo-electric substrate 1 early.

[0038] In this invention, it consists of aluminum or an aluminum alloy (an aluminum-Cu system, an aluminum-Ti system, aluminum-Si system, etc.), and aluminum and an aluminum-Cu system alloy have high excitation effectiveness, and since ingredient cost is low, the electric conduction film for SAW component 2a, the IDT electrodes 3a and 3b of 2b, Reflectors 4a and 4a and reflector 4b, and 4b has them. [especially desirable effectiveness] Moreover, said electric conduction film is formed by the thin film forming methods, such as vacuum deposition, the sputtering method, a CVD method, or the applying method.

[0039] and the electrode finger of the IDT electrodes 3a and 3b -- 50 to about 200 and electrode digital-furrow width of face are suitable for a logarithm, when about 0.1-10.0 micrometers and electrode finger spacing acquire a property expected [as a resonator or a filter] in about 0.1-10.0 micrometers and electrode finger aperture width (crossover width of face) setting thickness of about 10-100 micrometers and the IDT electrodes 3a and 3b to about 0.2-0.5 micrometers. Moreover, if piezoelectric material, such as a zinc oxide and an aluminum oxide, is formed between the electrode fingers of the IDT electrodes 3a and 3b, the resonance effectiveness of SAW improves and is suitable.

[0040] As a piezo-electric substrate 1 for the SAW equipments D, it is LiTaO3 of 36 degreeY cut-X propagation. LiNbO3 of a single crystal and 64 degreeY cut-X propagation LiB 4O7 of a single crystal and 45-degreeX cut-Z propagation Since [that an electromechanical coupling coefficient is / a single crystal etc. / large and] the group delay temperature coefficient is small, it is desirable. The thickness of the piezo-electric substrate 1 has about 0.3-0.5 goodmm, a piezo-

electric substrate becomes weak in less than 0.3mm, and ingredient cost becomes large in 0.5mm **.

[0041] In this way, in the 2nd photolithography process for making small a gap of the center frequency of each SAW equipment D, and desired uniform frequency characteristics and a filter shape being obtained, and forming an IDT electrode, even if the IDT electrode formed first reflects and the ultraviolet rays for exposure etc. are scattered about with it, this invention cannot be influenced [the] easily and has the operation effectiveness that the line breadth precision of patterning improves compared with the former as a result.

[0042] In addition, this invention is not limited to the above-mentioned operation gestalt, and modification various by within the limits which does not deviate from the summary of this invention does not interfere at all.

[0043]

[Example] The example of this invention is explained below.

[0044] (Example 1) It is the following, and the SAW equipment D of drawing 1 was made and produced. LiTaO3 of the 36 degreeY cut-X propagation by which both the principal plane was ground by the mirror plane as a piezo-electric substrate 1 SAW component 2a and 2b were formed in two principal planes, respectively by enforcing a process including a resist spreading process, a photolithography process, a vacuum deposition process, and a lift-off process for every principal plane using a crystal.

[0045] Specifically, it produced according to the process of the following (1) - (10).

[0046] (1) The resist of a positive type was applied to the front face (one principal plane) of the washed wafer for piezo-electric substrate 1 by about 1.0 micrometers of thickness, and it was dried at 90 degrees C.

[0047] (2) Use the photo mask by which patterning was carried out so that electrode digital-furrow width of face may be set to about 1.0 micrometers, and it is output 25.2 mW/cm2 at the wavelength of about 225nm. Ultraviolet rays performed adhesion exposure for about 4 seconds, and it was made to dry at 110 degrees C.

[0048] (3) It was immersed in the developer for 90 seconds, the resist of the exposure section was dissolved, the rinse was carried out with pure water, and the positive pattern of much SAW component 2a was formed in the resist film.
[0049] (4) The electric conduction film for SAW component 2a, a circuit pattern, and pad electrodes (aluminum-Cu alloy) was formed with vacuum evaporation technique by the thickness of about 3500A, and lift off of the unnecessary electric conduction film was carried out to the unnecessary resist with resist exfoliation liquid.
[0050] (5) The resist of a positive type was applied to the rear face (principal plane of another side) of a wafer by about 0.5 micrometers of thickness, and it was dried at 90 degrees C.
[0051] (6) Use the photo mask by which patterning was carried out so that electrode digital-furrow width of face may be set to about 0.5 micrometers, and it is output 25.2 mW/cm2 at the wavelength of about 225nm. Ultraviolet rays performed adhesion exposure for about 1.5 seconds, and it was made to dry at 110 degrees C.
[0052] (7) It was immersed in the developer for 90 seconds, the resist of the exposure section was dissolved, the rinse was carried out with pure water, and the positive pattern of much SAW component 2bs was formed in the resist film.
[0053] (8) The electric conduction film for SAW component 2b, a circuit pattern, and pad electrodes (aluminum-Cu alloy) was formed with vacuum evaporation technique by the thickness of about 3500A, and lift off of the unnecessary electric conduction film was carried out to the unnecessary resist with resist exfoliation liquid.
[0054] (9) the dicing method using the cooling water of about [specific resistance 10-20M-omegacm] pure water -- a wafer -- every -- it cut for every SAW equipment D.
[0055] (10) Each SAW equipment D was mounted in the package using the adhesives which consist of thermosetting resin, and wire bonding was performed.
[0056] Thus, SAW component 2a whose electrode digital-furrow width of face is

about 1.0 micrometers, respectively, and SAW component 2b whose electrode digital-furrow width of face is about 0.5 micrometers were produced to front flesh-side both sides of the piezo-electric substrate 1.

[0057] In this example, when the angle theta of the direction of an electrode finger of SAW component 2a and the direction of an electrode finger of SAW component 2b to make was made into 0 degree, 30 degrees, 60 degrees, 90 degrees, 120 degrees, and 150 degrees, it produced such SAW equipment D 20 pieces at a time respectively and gap 3sigma of such center frequency be measured, they were 9.9MHz, 8.6MHz, 5.4MHz, 4.3MHz, 5.8MHz and 8.4MHz, respectively.

[0058] moreover, in this example, the ultraviolet rays for exposure are reflected and scattered about at the time of SAW component 2b production with the electric conduction film for SAW component 2a formed first -- having -- being hard -- consequently, the former -- the line breadth of the electrode finger of SAW component 2b -- about 1.0 -- what was the precision beyond micrometer**0.15micrometer -- this example (theta= 60 degrees) -- about 1.0 -- it has been improved with micrometer**0.09micrometer.

[0059] (Example 2) After the above-mentioned process (8), it is SiO2. SAW equipment D was produced like the example 1 except having put the protective coat all over the wafer by the thickness of 250A by the sputtering method. Although the filter shape was measured before and after protective coat covering, it is changeless and the adhesion reinforcement of a wire was also over the desired value (5g pile) as a product with all products.

[0060] (Example 3) After the above-mentioned process (8), SAW equipment D was produced like the example 1 except having put the protective coat of Si all over the wafer by the thickness of 250A by the sputtering method. Although the filter shape was measured before and after protective coat covering, it is changeless and the adhesion reinforcement of a wire was also over the desired value (5g pile) as a product with all products.

[0061] (Example of a comparison) After the above-mentioned process (8), SAW

equipment D was produced like the example 1 except having put the protective coat of Si all over the wafer by the thickness of 600A by the sputtering method. It was changeless although the filter shape was measured before and after protective coat covering. However, the adhesion reinforcement of a wire was less than the desired value (5g pile) as a product, and about 10% of all products became a defective.

[0062]

[Effect of the Invention] This invention is SAW equipment which comes respectively to prepare the SAW component which has an IDT electrode in front flesh-side both sides of one piezo-electric substrate, when the direction of an electrode finger of the IDT electrode of front flesh-side both sides is not parallel, makes a gap of the center frequency of SAW equipment small, and has the operation effectiveness that desired uniform frequency characteristics and a filter shape are obtained. Moreover, in the 2nd photolithography process for forming an IDT electrode, even if the IDT electrode formed first reflects and the ultraviolet rays for exposure etc. are scattered about with it, it is [the] hard to be influenced and, as a result, the line breadth precision of patterning improves conventionally.

[0063] By preparing a protective coat at moreover, the time of the developer immersion in the pattern NINGU process of a resist aluminum of a pad electrode is etched with a developer, or aluminum of a pad electrode begins to melt into water according to the local battery effectiveness at the time of the pure-water rinse after development, Furthermore, since aluminum begins to melt by contacting the pad electrode with which cooling water is not covered by the protective coat in case the wafer for piezo-electric substrates is cut by the dicing method, problems, such as degradation of frequency characteristics, a fall of dependability, and a fall of the adhesion reinforcement of wire bond, are solvable.

[0064] Furthermore, by said protective coat, discharge arises between the electrode fingers of an IDT electrode and a reflector according to the pyroelectric effect of a piezo-electric substrate at the time of heat treatment of the pattern NINGU process of a resist, a packaging process, a wire-bonding process, etc.,

and it controls and prevents at it that an electrode finger is damaged. Moreover, a semi-conductive protective coat has the large effectiveness of discharge control. Or it can prevent that a conductive foreign matter invades into IDT inter-electrode, and between electrode fingers short-circuits by the protective coat, consequently the manufacture yield improves, and dependability also becomes high.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the perspective view of the SAW equipment D of this invention.

[Drawing 2] Other operation gestalten of this invention are shown and it is the perspective view of SAW equipment Da.

[Drawing 3] In the SAW equipment D of this invention, it is the graph which shows the relation of angle theta and the gap of center frequency which the direction of an electrode finger of each SAW component makes.

[Drawing 4] Conventional SAW equipment D1 It is shown and (a) is SAW equipment D1. A perspective view and (b) are the sectional views in the A-A line of (a).

[Drawing 5] Degradation of the line breadth precision of conventional SAW equipment is explained, and it is the fragmentary sectional view of the piezo-electric substrate in the 2nd photolithography process.

[Description of Notations]

1: A piezo-electric substrate

2a: SAW component

2b: SAW component

3a, 3 b:IDT electrodes

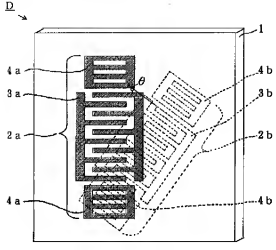
4a, 4b: Reflector

[Translation done.]

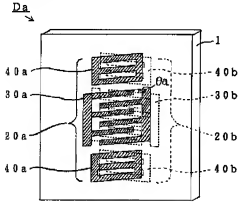
* NOTICES *

DRAWINGS

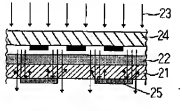
[Drawing 1]



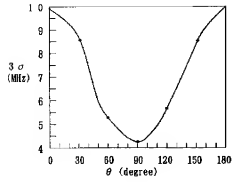
[Drawing 2]



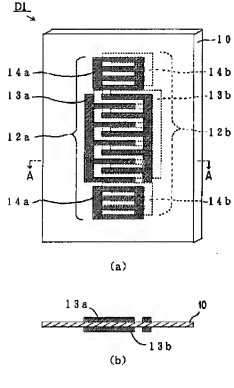
[Drawing 5]



[Drawing 3]



[Drawing 4]



[Translation done.]

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3/08			3/08	
9/64			9/64	Ｚ

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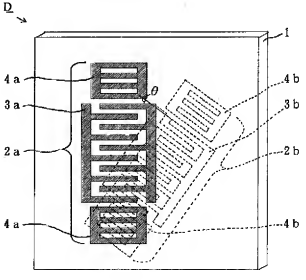
(54)【発明の名称】　弾性表面波装置

(57)【要約】
【課題】ＳＡＷ装置の中心周波数のずれを小さくして、所望の均一な周波数特性、フィルタ特性が得られ、またＩＤＴ電極の線幅精度を高精度に形成可能とする。
【解決手段】圧電基板１の表裏両面に一対のＩＤＴ電極３ａ，３ｂを有するＳＡＷ素子２ａ，２ｂを各々設けてなるＳＡＷ装置Ｄであって、各々のＳＡＷ素子２ａ，２ｂのＩＤＴ電極３ａ，３ｂの電極指方向が互いに非平行である。



【特許請求の範囲】
【請求項１】複数の平行な電極指を交互に噛み合わせるように構成した一対の櫛歯状電極を有する弾性表面波素子を、一枚の圧電基板の表裏両面に各々設けてなる弾性表面波装置であって、前記表裏両面に形成した櫛歯状電極の電極指方向が互いに非平行であることを特徴とする弾性表面波装置。
【請求項２】前記表裏両面の櫛歯状電極の電極指方向のなす角θが、$30° \leq \theta \leq 150°$である請求項１記載の弾性表面波装置。
【請求項３】前記圧電基板がタンタル酸リチウム単結晶からなり、$36.3° \leq \theta \leq 143.7°$である請求項２記載の弾性表面波装置。
【請求項４】前記圧電基板の表裏両面の全面に、膜厚５００Å以下の絶縁性又は半導電性の保護膜が被着されている請求項１～３のいずれかに記載の弾性表面波装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、携帯電話等の移動体通信機器に用いられる弾性表面波装置、例えばデュアルモードの弾性表面波装置に関する。
【０００２】
【従来の技術】従来のデュアルモードの弾性表面波（Surface Acoustic Wave で、以下、ＳＡＷと略す）装置Ｄ１の一例を図４に示す。同図（ａ）はＳＡＷ装置Ｄ１の斜視図、（ｂ）は（ａ）のＡ－Ａ線における断面図である。
【０００３】同図において、圧電基板１０の両主面（表裏両面）に、通過帯域特性等の周波数特性の異なる２つのＳＡＷ素子１２ａ，１２ｂが設けられている。これらのＳＡＷ素子１２ａ，１２ｂは、各々少なくとも一対の櫛歯状電極（Inter DigitalTransducerで、以下、ＩＤＴ電極という）１３ａ，１３ｂを有し、場合によってはＩＤＴ電極１３ａ，１３ｂのＳＡＷ伝搬路の両端に、ＳＡＷを反射し効率良く共振させるための反射器１４ａ，１４ａ，１４ｂ，１４ｂを設ける（特開平２－２１８２０９号公報参照）。
【０００４】また、デュアルモードのＳＡＷ装置として、圧電基板１０の一方の主面に周波数特性の異なる２つのＳＡＷ素子を設けたものもある。
【０００５】近年、セルラー電話，デジタルコードレス電話等の移動体通信機器には、種々の信号処理システムが使用されているが、同時に２種類の信号処理システムに対応可能な併用機の開発が活発になってきている。従って、上記のような、中心周波数，通過帯域幅等の異なる２つの信号処理システムに対応できる、デュアルモードのＳＡＷ装置に対する要望が大きくなってきている。
【０００６】
【発明が解決しようとする課題】しかしながら、上記の圧電基板１０の表裏面にＩＤＴ電極１３ａ，１３ｂを形成するものの場合、個々のＳＡＷ装置Ｄ１間で、中心周波数がずれ易いという問題点があった。それは、以下のような原因によると考えられる。
【０００７】即ち、図５に示すように、フォトリソグラフィ工程，真空蒸着工程，リフトオフ工程等から成るＩＤＴ電極２５形成工程を、圧電基板２１の表裏面に対して各々一回ずつ施しているが、２回目のＩＤＴ電極２５形成工程のフォトリソグラフィ工程において、レジスト膜２２をフォトマスク２４を通してパターニングするための露光用の紫外線２３が、最初に形成されたＳＡＷ素子のＩＤＴ電極２５によって反射、散乱され、２回目に形成されたＩＤＴ電極２５のパターニングの線幅精度が低下し、その結果中心周波数が設計値からずれるという理由による。
【０００８】また、圧電基板の一主面に２種類のＳＡＷ素子を並べて設置することもできるが、フォトリソグラフィ工程で２種類のフォトマスクを、同時又は別々に使用する必要があり、その結果、これらＳＡＷ素子の近接部で露光用の紫外線が干渉したり、隣の形成済のパターンあるいは電極指から光が反射、散乱されて、パターニングの線幅精度が低下していた。これらのＳＡＷ素子が近接すればするほどその影響が大きかった。
【０００９】従って、本発明は上記事情に鑑みて完成されたものであり、その目的は圧電基板の表裏面に２種のＳＡＷ素子を形成して成るＳＡＷ装置において、個々のＳＡＷ装置間での中心周波数のずれを小さくして、所望の均一な周波数特性、フィルタ特性が得られるようにし、またＩＤＴ電極の線幅精度を高精度に形成可能とすることにある。
【００１０】
【課題を解決するための手段】本発明の弾性表面波装置は、複数の平行な電極指を交互に噛み合わせるように構成した一対の櫛歯状電極を有する弾性表面波素子を、一枚の圧電基板の表裏両面に各々設けてなる弾性表面波装置であって、前記表裏両面に形成した櫛歯状電極の電極指方向が互いに非平行であることを特徴とし、このような構成により、個々の弾性表面波装置の中心周波数のずれを小さくして、所望の均一な周波数特性、フィルタ特性が得られるようにし、また櫛歯状電極の線幅精度が高精度に形成可能となる。本発明において、好ましくは、前記表裏両面の櫛歯状電極の電極指方向のなす角θが、$30° \leq \theta \leq 150°$である。また好ましくは、前記圧電基板がタンタル酸リチウム単結晶からなり、$36.3° \leq \theta \leq 143.7°$である。
【００１１】更に好ましくは、前記圧電基板の表裏両面の全面に、膜厚５００Å以下の絶縁性又は半導電性の保護膜が被着されており、これにより、耐環境性が向上し、更に熱処理時の高温による圧電基板の焦電効果で櫛歯状電極の電極指間に放電が生じ、櫛歯状電極がショートしたり、損傷するのを抑制、防止できる。

【００１２】
【発明の実施の形態】本発明を図１～図３を用いて説明する。図１は本発明のＳＡＷ装置Ｄの基本構成の斜視図である。同図において、１は３６°Ｙカット－Ｘ伝搬のタンタル酸リチウム（$LiTaO_3$）単結晶等からなる一枚の圧電基板、２ａ，２ｂはそれぞれ圧電基板１の表裏両面（両主面）に設けられた２つのＳＡＷ素子、３ａ，３ｂは複数の平行な電極指を交互に噛み合わせるように構成した一対の櫛歯状電極のＩＤＴ電極、４ａ，４ａはＩＤＴ電極３ａのＳＡＷの伝搬路の両端に設けられた反射器、４ｂ，４ｂはＩＤＴ電極３ｂのＳＡＷの伝搬路の両端に設けられた反射器である。これらのＳＡＷ素子２ａ，２ｂは、ＩＤＴ電極３ａ，３ｂの各々の電極指方向が互いに非平行とされている。
【００１３】このように、電極指方向を非平行とすると、以下のような作用により中心周波数のずれが小さくなると考えられる。
【００１４】つまり、２個目のＳＡＷ素子（例えばＳＡＷ素子２ｂ）を作製する際に、２回目の露光用の紫外光が１回目に作製したＳＡＷ素子２ａのＩＤＴ電極３ａによって反射、散乱されるが、その反射及び散乱の主な方向は、ＩＤＴ電極３ａの電極指方向（電極指の長手方向）に対して垂直な方向であると推定される。例えば、電極指方向が平行でＳＡＷ素子２ａ，２ｂがほぼ重なっている場合、ＩＤＴ電極３ａによる反射光及び散乱光が、ＩＤＴ電極３ｂの電極指の線幅方向で入射し、直接電極指の線幅に影響を与える。そこで、電極指方向を非平行とすると、そのなす角θにしたがって、ＩＤＴ電極３ｂの電極指の線幅方向に入射する紫外光の強度は減少し、線幅精度が劣化し難くなり、その結果中心周波数のずれが小さくなると考えられる。
【００１５】図２は、本発明の他の実施形態を示し、ＳＡＷ装置Ｄａの基本構成の斜視図である。同図において、１０は３６°Ｙカット－Ｘ伝搬のタンタル酸リチウム（$LiTaO_3$）単結晶等からなる圧電基板、２０ａ，２０ｂはそれぞれ圧電基板１の表裏両面に設けられた２つのＳＡＷ素子、３０ａ，３０ｂはＩＤＴ電極、４０ａ，４０ａはＩＤＴ電極３０ａのＳＡＷの伝搬路の両端に設けられた反射器、４０ｂ，４０ｂはＩＤＴ電極３０ｂのＳＡＷの伝搬路の両端に設けられた反射器である。これらのＳＡＷ素子２０ａ，２０ｂは、ＩＤＴ電極３０ａ，３０ｂの電極指がバスバーに対して斜めに形成されている。
【００１６】一般的に、ＳＡＷは電極指に対し垂直方向に伝搬するので、バスバーに対する電極指の傾斜角が大きすぎると、ＳＡＷの伝搬路がＩＤＴ電極３０ａ端部の電極指からはずれてくる。従って、バスバーに対する傾斜角は最大３０°程度であり、３０°よりも大きいと共振子及びフィルタとしての所期の特性が得難い。
【００１７】従って、ＳＡＷ素子２０ａの電極指方向とＳＡＷ素子２０ｂの電極指方向のなす角θａは、$0° < \theta a \leqq 60°$とするのがよい。より好ましくは、$5° < \theta a \leqq 45°$程度がよい。５°より小さいと本発明の効果が得難く、４５°より大きいとＳＡＷの共振効率が低下し損失が増大し易い。
【００１８】そして、図３は、図１のものについて圧電基板を３６°Ｙカット－Ｘ伝搬のタンタル酸リチウム単結晶とし、電極指方向がなす角θを種々に変化させたＳＡＷ装置Ｄを複数個ずつ作製し、それらの通過帯域の中心周波数のずれを縦軸の3σ（σ：標準偏差）で表し、横軸をθとしたグラフである。同図に示すように、θが３０°程度を境にして3σ（σ：標準偏差）が急激に小さくなっており、同様にθが１５０°程度以下で3σが急激に小さくなる。従って、$30° \leqq \theta \leqq 150°$が好適である。
【００１９】更に、圧電基板が３６°Ｙカット－Ｘ伝搬のタンタル酸リチウム単結晶の場合、通過帯域と阻止帯域との間隔は一般に２０ＭＨｚ、温度変化（動作温度範囲：－３０℃～８０℃）による通過帯域端部のシフト量は±４ＭＨｚ、通過帯域端部の傾斜領域が４ＭＨｚであることから、中心周波数のばらつきを２０－４×２－４＝８ＭＨｚ以下に抑さえれる。従って、図２において、中心周波数のばらつきが８ＭＨｚ以下になる領域は、$36.3° \leqq \theta \leqq 143.7°$であることが判明した。
【００２０】本発明のＳＡＷ素子２ａ，２ｂは、それぞれ中心周波数，通過帯域幅等の周波数特性が異なるフィルタ、所謂デュアルモードのＳＡＷフィルタであっても良いが、同じ周波数特性のものであっても構わない。また、一主面に同じＳＡＷ素子を複数設けて、例えば２．５段π型，２．５段Ｔ型，３段型等のラダー型ＳＡＷフィルタを構成しても良い。
【００２１】本発明のＳＡＷ装置Ｄが上記のデュアルモードのＳＡＷフィルタである場合、ＳＡＷ素子２ａ，２ｂのＩＤＴ電極３ａ，ＩＤＴ電極３ｂは、それぞれ電極指ピッチ，電極指線幅が異なっており、反射器４ａ，４ａと反射器４ｂ，４ｂも同様に異なる。これらのＩＤＴ電極３ａ，ＩＤＴ電極３ｂ，反射器４ａ，４ａ，反射器４ｂ，４ｂは、ポジ型（露光により溶解するタイプ）あるいはネガ型（露光により溶解しないタイプ）のレジスト塗布工程、フォトリソグラフィ工程、真空蒸着法，スパッタリング法，ＣＶＤ法，塗布法等による導電膜の薄膜形成工程、リフトオフ法，エッチング法等による不要レジスト及び不要導電膜の除去工程を含む製法により形成される。
【００２２】例えば、以下のような工程（１）～（６）によって作製される。
【００２３】（１）表面を研磨した３６°Ｙカット－Ｘ伝搬のタンタル酸リチウム単結晶の圧電基板１を洗浄し、その一主面（表面）にレジストを約１．０μｍの膜

厚で塗布し、90℃で乾燥させる。

【0024】（2）IDT電極3a等の電極線幅を約1μmで形成するフォトマスクを用いて、波長約225nm，出力25．2mW／cm² の紫外光により約4秒間密着露光を行い、110℃で乾燥させ、現像液に浸漬して現像を90秒行い、純水でリンスする。

【0025】（3）IDT電極3a及び反射器4a，4aⅡのA1を真空蒸着法により形成し、レジスト剥離液によりレジストとA1の不要部をリフトオフする。

【0026】（4）圧電基板1の他方の主面（裏面）にレジストを約0．5μmの膜厚で塗布し、90℃で乾燥させる。

【0027】（5）IDT電極3b等の電極線幅を約0．5μmで形成するフォトマスクを用いて、波長約225nm，出力25．2mW／cm² の紫外光により約1．5秒間密着露光を行い、110℃で乾燥させ、現像液に浸漬して現像を90秒行い、純水でリンスする。

【0028】（6）IDT電極3b及び反射器4b，4bⅡのA1を真空蒸着法により形成し、レジスト剥離液によりレジストとA1の不要部をリフトオフする。

【0029】このようにして、圧電基板1の表面側にIDT電極3aの電極指の線幅1μmのSAW素子2aと、裏面側にIDT電極3bの電極指の線幅0．5μmのSAW素子2bを形成する。

【0030】本発明において、組織化されたIDT電極3a，3bを多用するSAW素子2a，2bが形成された圧電基板1の表裏両面の全面に、500Å以下の保護膜を被着することが好ましい。保護膜を設けることにより、以下の（1）～（4）のような効果が得られる。

【0031】（1）従来、保護膜は例えばパッド電極を除いて形成するように、レジストによりパターンニングされた上に成膜され、次いでエッチング法やリフトオフ法により不要な部分を除去していたが、このパターンニング工程における現像液浸漬時に、パッド電極用のA1合金（A1－Cu系，A1－Ti系，A1－Si系等）が現像液によりエッチングされ、周波数特性の劣化及び信頼性の低下をきたしていたのを防止する。

【0032】（2）前記パターンニング工程における現像後の純水リンス時に、パッド電極のA1が局部電池効果により水に溶け出し、周波数特性の劣化及び信頼性の低下が生じていたのを防止する。

【0033】（3）圧電基板1用のウェハをダイシング法でカットする際に、冷却水が保護膜で覆われていないパッド電極に接触することでA1が溶け出し、ワイヤーボンドの密着強度が低下していたのを防ぐことができる。

【0034】（4）パターンニング工程におけるレジスト塗布後の乾燥工程、ワイヤーボンディング工程、パッケージング工程等の熱処理時に、圧電基板1の焦電効果によってIDT電極3a，3b及び反射器4a，4a，4b，4bの電極指間に放電が生じ、電極指が損傷するのを抑制、防止する。

【0035】前記保護膜は、SiO_2，SiO，Cr－SiO_2，Cr－SiO，SiN等の絶縁性もの、又は膜方向（膜に平行な方向）の抵抗が10^9～10^{13}Ω程度の半導電性（半導伝性）のもので、Si，Ta，Mo，Ge，NiCr，NiCr－Si，Taの酸化物又は窒化物，Moの酸化物又は窒化物，Geの酸化物又は窒化物等である。10^9 Ω未満では電極指間がショートし易くなり、10^{13}Ω超では電荷の中和作用が低下する。前記半導電性の保護膜は、絶縁性のものと比較して放電の発生率を約30％～約50％に低減できる。これは、半導電性の保護膜が電極指間の電荷密度差を緩和し易いからである。また、パッド電極での電気抵抗が小さくなり、フィルタ特性の劣化が絶縁性のものより小さい。このような保護膜は、公知の蒸着法，スパッタリング法，CVD法等の薄膜形成法により形成する。

【0036】保護膜の厚みは500Å以下が良く、500Åを超えると、ワイヤーをパッド電極に直接ボンディングすることが困難になり、その結果、ボンディング後のワイヤーの密着強度が低下する。また、ボンディング部の電気抵抗が大きくなり、フィルタ特性等の周波数特性が劣化する。より好ましくは、25～500Åが良く、25Å未満では保護膜としての効果がほとんどなくなる。

【0037】また、圧電基板1の一主面において、少なくとも一個のSAW素子と配線パターン及び外部導出用のパッド電極用の導電膜を、前記一主面の面積の25％以上に形成するのがより好ましい。この構成により、空気中に浮遊した電荷を捕獲する速度が早い導電膜の面積が大きくなり、導電膜及び圧電基板1上の電荷を早く中和する。

【0038】本発明において、SAW素子2a，2bのIDT電極3a，3b，反射器4a，4a及び反射器4b，4b用の導電膜は、A1あるいはA1合金（A1－Cu系，A1－Ti系，A1－Si系等）からなり、特にA1，A1－Cu系合金が弾振効率が高く、材料コストが低いため好ましい。また、前記導電膜は蒸着法，スパッタリング法，CVD法又は塗布法等の薄膜形成法により形成する。

【0039】そして、IDT電極3a，3bの電極指対数は50～200程度、電極指線幅は0．1～10．0μm程度、電極指間隔は0．1～10．0μm程度、電極指間口幅（交差幅）は10～100μm程度、IDT電極3a，3bの厚みは0．2～0．5μm程度とすることが、共振器あるいはフィルタとしての所期の特性を得る上で好適である。また、IDT電極3a，3bの電極指間に酸化珪鉛，酸化アルミニウム等の圧電材料を成膜すれば、SAWの共振効率が向上し好適である。

【0040】SAW装置D用の圧電基板1としては、3

６°Ｙカット－Ｘ伝搬のＬｉＴａO_3単結晶、６４°Ｙカット－Ｘ伝搬のＬｉＮｂO_3単結晶、４５°Ｘカット－Ｚ伝搬のＬｉB_4 O_7単結晶等が、電気機械結合係数が大きく且つ群遅延時間温度係数が小さいため好ましい。圧電基板１の厚みは０．３～０．５ｍｍ程度がよく、０．３ｍｍ未満では圧電基板が脆くなり、０．５ｍｍ超では材料コストが大きくなる。

【００４１】かくして、本発明は、個々のＳＡＷ装置Ｄの中心周波数のずれを小さくして、所望の均一な周波数特性、フィルタ特性が得られ、またＩＤＴ電極を形成するための２回目のフォトリソグラフィ工程において、露光用の紫外線等が最初に形成されたＩＤＴ電極によって反射、散乱されても、その影響を受け難く、その結果従来に比べてパターニングの線幅精度が向上するという作用効果を有する。

【００４２】なお、本発明は上記の実施形態に限定されるものではなく、本発明の要旨を逸脱しない範囲内で種々の変更は何等差し支えない。

【００４３】

【実施例】本発明の実施例を以下に説明する。

【００４４】（実施例１）図１のＳＡＷ装置Ｄを以下のようにして作製した。圧電基板１として、その両主面が鏡面に研磨された３６°Ｙカット－Ｘ伝搬のＬｉＴａO_3結晶を用い、レジスト塗布工程，フォトリソグラフィ工程，真空蒸着工程，リフトオフ工程を含む製法を各主面毎に実施することにより、２つの主面にＳＡＷ素子２ａ，２ｂをそれぞれ形成した。

【００４５】具体的には以下の（１）～（10）の工程により作製した。

【００４６】（１）洗浄した圧電基板１用のウェハの表面（一主面）に、ポジ型のレジストを膜厚約１．０μｍで塗布し、９０℃で乾燥させた。

【００４７】（２）電極指線幅が約１．０μｍとなるようパターニングされたフォトマスクを用いて、波長約２２５ｎｍで出力２５．２ｍＷ／ｃｍ^{2}の紫外線により約４秒間密着露光を行い、１１０℃で乾燥させた。

【００４８】（３）現像液に９０秒間浸漬して露光部のレジストを溶解し、純水でリンスしてレジスト膜に多数のＳＡＷ素子２ａのポジパターンを形成した。

【００４９】（４）ＳＡＷ素子２ａ、配線パターン及びパッド電極用の導電膜（Ａｌ－Ｃｕ合金）を、約３５００Åの厚みで真空蒸着法により形成し、レジスト剥離液により不要レジストと不要導電膜をリフトオフした。

【００５０】（５）ウェハの裏面（他方の主面）に、ポジ型のレジストを膜厚約０．５μｍで塗布し、９０℃で乾燥させた。

【００５１】（６）電極指線幅が約０．５μｍとなるようパターニングされたフォトマスクを用いて、波長約２２５ｎｍで出力２５．２ｍＷ／ｃｍ^{2}の紫外線により約１．５秒間密着露光を行い、１１０℃で乾燥させた。

【００５２】（７）現像液に９０秒間浸漬して露光部のレジストを溶解し、純水でリンスしてレジスト膜に多数のＳＡＷ素子２ｂのポジパターンを形成した。

【００５３】（８）ＳＡＷ素子２ｂ、配線パターン及びパッド電極用の導電膜（Ａｌ－Ｃｕ合金）を約３５００Åの厚みで真空蒸着法により形成し、レジスト剥離液により不要レジストと不要導電膜をリフトオフした。

【００５４】（９）比抵抗１０～２０ＭΩｃｍ程度の純水の冷却水を用いたダイシング法により、ウェハを各ＳＡＷ装置Ｄ毎にカットした。

【００５５】(10) 各ＳＡＷ装置Ｄを熱硬化性樹脂から成る接着剤を用いてパッケージに実装し、ワイヤーボンディングを行った。

【００５６】このようにして、圧電基板１の表裏両面に、それぞれ電極指線幅が約１．０μｍのＳＡＷ素子２ａと電極指線幅が約０．５μｍのＳＡＷ素子２ｂとを作製した。

【００５７】本実施例においては、ＳＡＷ素子２ａの電極指方向とＳＡＷ素子２ｂの電極指方向とのなす角θを０°，３０°，６０°，９０°，１２０°，１５０°とし、このようなＳＡＷ装置Ｄを各々２０個ずつ作製し、これらの中心周波数のずれ３σを測定したところ、それぞれ９．９ＭＨｚ，８．６ＭＨｚ，５．４ＭＨｚ，４．３ＭＨｚ，５．８ＭＨｚ，８．４ＭＨｚであった。

【００５８】また、本実施例では、最初に形成したＳＡＷ素子２ａ用の導電膜によりＳＡＷ素子２ｂ作製時に露光用の紫外線が反射、散乱されにくくなり、その結果、従来ＳＡＷ素子２ｂの電極指の線幅が約１．０μｍ±０．１５μｍ以上の精度であったものが、本実施例（θ＝６０°）では約１．０μｍ±０．０９μｍと改善された。

【００５９】（実施例２）上記工程（８）の後に、SiO_2の保護膜をスパッタリング法により２５０Åの厚みでウェハ全面に被着した以外は、実施例１と同様にしてＳＡＷ装置Ｄを作製した。保護膜被着の前後でフィルタ特性を測定したが変化はなく、また、ワイヤーの密着強度も全製品で製品としての要求値（５ｇ重）を超えていた。

【００６０】（実施例３）上記工程（８）の後に、Ｓｉの保護膜をスパッタリング法により２５０Åの厚みでウェハ全面に被着した以外は、実施例１と同様にしてＳＡＷ装置Ｄを作製した。保護膜被着の前後でフィルタ特性を測定したが変化はなく、また、ワイヤーの密着強度も全製品で製品としての要求値（５ｇ重）を超えていた。

【００６１】（比較例）上記工程（８）の後に、Ｓｉの保護膜をスパッタリング法により６００Åの厚みでウェハ全面に被着した以外は、実施例１と同様にしてＳＡＷ装置Ｄを作製した。保護膜被着の前後でフィルタ特性を測定したが変化はなかった。しかし、全製品のうち約１０％が、ワイヤーの密着強度が製品としての要求値（５

ｇ重）を下回り、不良品となった。

【００６２】

【発明の効果】本発明は、一枚の圧電基板の表裏両面にＩＤＴ電極を有するＳＡＷ素子を各々設けてなるＳＡＷ装置であって、表裏両面のＩＤＴ電極の電極指方向が非平行であることにより、ＳＡＷ装置の中心周波数のずれを小さくして、所望の均一な周波数特性、フィルタ特性が得られるという作用効果を有する。また、ＩＤＴ電極を形成するための２回目のフォトリソグラフィ工程において、露光用の紫外線等が最初に形成されたＩＤＴ電極によって反射、散乱されても、その影響を受け難く、その結果従来よりもパターニングの線幅精度が向上する。

【００６３】また、保護膜を設けることにより、レジストのパターニング工程における現像液浸漬時に、バッド電極のＡ１が現像液によりエッチングされたり、現像後の純水リンス時にバッド電極のＡ１が局部電池効果により水に溶け出すこと、更には圧電基板用のウェハをダイシング法でカットする際に、冷却水が保護膜で覆われていないバッド電極に接触することでＡ１が溶け出すことから、周波数特性の劣化、信頼性の低下及びワイヤーボンドの密着強度の低下といった問題を解消することができる。

【００６４】更に、前記保護膜により、レジストのパターニング工程、パッケージング工程、ワイヤーボンディング工程等の熱処理時に、圧電基板の焦電効果によってＩＤＴ電極及び反射器の電極指間に放電が生じ、電極指が損傷するのを抑制、防止する。また、半導電性の保護膜は放電抑制の効果が大きい。あるいは、保護膜により、ＩＤＴ電極間に導電性の異物が侵入して電極指間がショートすることを防止でき、その結果、製造歩留りが向上し、信頼性も高くなる。

【図面の簡単な説明】

【図１】本発明のＳＡＷ装置Ｄの斜視図である。

【図２】本発明の他の実施形態を示し、ＳＡＷ装置Ｄａの斜視図である。

【図３】本発明のＳＡＷ装置Ｄにおいて、各ＳＡＷ素子の電極指方向のなす角θと中心周波数のずれとの関係を示すグラフである。

【図４】従来のＳＡＷ装置Ｄ１を示し、（ａ）はＳＡＷ装置Ｄ１の斜視図、（ｂ）は（ａ）のＡ－Ａ線における断面図である。

【図５】従来のＳＡＷ装置の線幅精度の劣化を説明するもので、２回目のフォトリソグラフィ工程における圧電基板の部分断面図である。

【符号の説明】

１：圧電基板

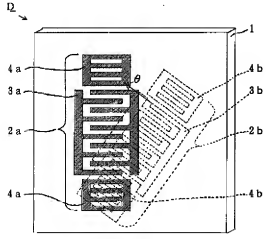
２ａ：ＳＡＷ素子

２ｂ：ＳＡＷ素子

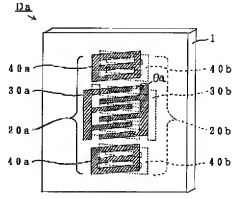
３ａ，３ｂ：ＩＤＴ電極

４ａ，４ｂ：反射器

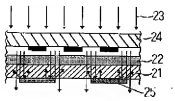
【図１】



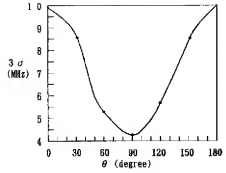
【図２】



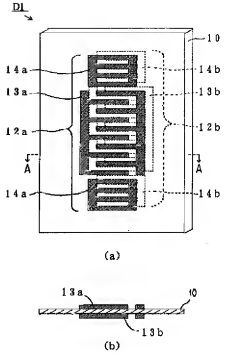
【図５】



【図３】



【図４】



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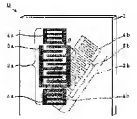
(54) SURFACE ACOUSTIC WAVE DEVICE



(57)Abstract:

PROBLEM TO BE SOLVED: To secure both frequency and filter characteristics as desired and to improve the line width accuracy of a comb-like electrode by

setting the electrode finger directions of the comb-like electrode in non-parallel to each other on both sides and accordingly reducing the difference of center frequency between the surface acoustic wave(SAW) devices.
SOLUTION: When an SAW device 2b is produced, the 2nd exposure ultraviolet rays are reflected and scattered on an IDT electrode 3a of an SAW device 2a that is first produced. This reflecting/scattering direction is vertical to the electrode finger directions of the electrode 3a. If the directions of electrode fingers of both devices 2a and 2b are overlapping each other, for example, the rays reflected and scattered by the electrode 3a are made incident in the line width directions of fingers of an IDT electrode 3b and therefore directly affect the line widths of the electrode digitals. In this respect, the directions of electrode fingers are set in non-parallel to each other forming an angle θ between the directions. As a result, the intensity of the ultraviolet rays incident in the line width directions of the fingers of the electrode 3b are reduced according to an angle θ and accordingly the line width accuracy is not easily deteriorated. Thus, the difference of center frequency can be reduced between both devices 2a and 2b.

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CLAIMS

[Claim(s)]

[Claim 1] Surface acoustic wave equipment characterized by the direction of an electrode finger of the ctenidium-like electrode which is surface acoustic wave equipment which it comes to prepare in front flesh-side both sides of one piezo-electric substrate respectively, and formed in said table flesh-side both sides the surface acoustic element which has the ctenidium-like electrode of the pair constituted so that two or more parallel electrode fingers might be engaged by turns not being mutually parallel.

[Claim 2] Surface acoustic wave equipment according to claim 1 whose angle theta which the direction of an electrode finger of the ctenidium-like electrode of said table flesh-side both sides makes is 30 degrees <= theta<=150 degrees.

[Claim 3] Surface acoustic wave equipment according to claim 2 which said piezo-electric substrate consists of a lithium tantalate single crystal, and is 36.3 degrees <= theta<=143.7 degrees.

[Claim 4] Surface acoustic wave equipment according to claim 1 to 3 on which

the insulating or semi-conductive protective coat of 500A or less of thickness is put all over front flesh-side both sides of said piezo-electric substrate.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention relates to the surface acoustic wave equipment used for mobile communication equipment, such as a cellular phone, for example, the surface acoustic wave equipment of a dual mode.

[0002]

[Description of the Prior Art] Surface acoustic wave (by Surface Acoustic Wave, it abbreviates to SAW hereafter) equipment D1 of the conventional dual mode An example is shown in drawing 4 . This drawing (a) is SAW equipment D1. A perspective view and (b) are the sectional views in the A-A line of (a).

[0003] In this drawing, two SAW components 12a and 12b from which frequency characteristics, such as a passband property, differ in both the principal planes (front flesh-side both sides) of the piezo-electric substrate 10 are formed. The reflectors 14a, 14a, 14b, and 14b for these SAW components 12a and 12b

having the ctenidium-like electrodes (henceforth [it is Inter DigitalTransducer and] an IDT electrode) 13a and 13b of a pair at least respectively, reflecting SAW in the both ends of the SAW propagation path of the IDT electrodes 13a and 13b depending on the case, and making it resonate efficiently are formed (refer to JP,2-218209,A).

[0004] Moreover, there are some which prepared two SAW components from which frequency characteristics differ in one principal plane of the piezo-electric substrate 10 as SAW equipment of a dual mode.

[0005] Although various signal processing systems are used for mobile communication equipment, such as a cellular phone and a digital cordless telephone, in recent years, development of the concomitant use machine which can be equivalent to two kinds of signal processing systems at coincidence is becoming active. Therefore, the request to the SAW equipment of a dual mode which can be equivalent to two different signal processing systems, such as above center frequency, pass band width, etc., is becoming large.

[0006]

[Problem(s) to be Solved by the Invention] however -- although the IDT electrodes 13a and 13b are formed in the front rear face of the above-mentioned piezo-electric substrate 10 -- a case -- each SAW equipment D1 In between, there was a trouble that center frequency tends to shift. It is considered to be based on the following causes.

[0007] Namely, although IDT electrode 25 formation process which consists of a photolithography process, a vacuum deposition process, a lift-off process, etc. is respectively given by a unit of 1 time to the front rear face of the piezo-electric substrate 21 as shown in drawing 5 In the photolithography process of the 2nd IDT electrode 25 formation process The ultraviolet rays 23 for the exposure for carrying out patterning of the resist film 22 through a photo mask 24 It is reflected and scattered about with the IDT electrode 25 of the SAW component formed first, the line breadth precision of patterning of the IDT electrode 25 formed in the 2nd time falls, and it is based on the reason center frequency shifts from a design

value as a result.
[0008] Moreover, although two kinds of SAW components could also be put in order and installed in one principal plane of a piezo-electric substrate, in the contiguity section of these SAW(s) component, it needed to be used separately, consequently it reflected, light was scattered [the ultraviolet rays for exposure interfered, or] about from coincidence, the pattern [finishing / the next formation], or the electrode finger in two kinds of photo masks by the photolithography process, and the line breadth precision of patterning was falling. The effect was larger as these SAW components approached.
[0009] Therefore, it is in this invention being completed in view of the above-mentioned situation, and making small a gap of the center frequency between each SAW equipment in the SAW equipment which the purpose forms two sorts of SAW components in the front rear face of a piezo-electric substrate, and changes, and desired uniform frequency characteristics and a filter shape being obtained, and enabling formation of the line breadth precision of an IDT electrode with high precision.
[0010]
[Means for Solving the Problem] The surface acoustic wave equipment of this invention the surface acoustic element which has the ctenidium-like electrode of the pair constituted so that two or more parallel electrode fingers might be engaged by turns It is characterized by the direction of an electrode finger of the ctenidium-like electrode which is surface acoustic wave equipment and was formed in said table flesh-side both sides which it comes to prepare in front flesh-side both sides of one piezo-electric substrate respectively not being mutually parallel. By such configuration A gap of the center frequency of each surface acoustic wave equipment is made small, and desired uniform frequency characteristics and a filter shape are obtained, and formation of the line breadth precision of a ctenidium-like electrode is attained with high precision. In this invention, the angle theta which the direction of an electrode finger of the ctenidium-like electrode of said table flesh-side both sides makes is 30 degrees

<= theta<=150 degrees preferably. Moreover, preferably, said piezo-electric substrate consists of a lithium tantalate single crystal, and is 36.3 degrees <= theta<=143.7 degrees.

[0011] Furthermore, preferably, all over front flesh-side both sides of said piezo-electric substrate, the insulating or semi-conductive protective coat of 500A or less of thickness is put, and a resistance to environment improves and discharge arises between the electrode fingers of a ctenidium-like electrode further in the pyroelectric effect of the piezo-electric substrate by the elevated temperature at the time of heat treatment, and a ctenidium-like electrode can short-circuit, or, thereby, it can control and prevent being damaged.

[0012]

[Embodiment of the Invention] This invention is explained using drawing 1 - drawing 3 . Drawing 1 is the perspective view of the basic configuration of the SAW equipment D of this invention. One piezo-electric substrate with which 1 consists of a lithium tantalate (LiTaO3) single crystal of 36 degreeY cut-X propagation etc. in this drawing, 2a, two SAW components with which 2b was prepared in front flesh-side both sides (both principal planes) of the piezo-electric substrate 1, respectively, The IDT electrode of the ctenidium-like electrode of the pair constituted so that 3a and 3b might engage two or more parallel electrode fingers by turns, the reflector with which 4a and 4a were prepared in the both ends of the propagation path of SAW of IDT electrode 3a, and 4b and 4b are the reflectors prepared in the both ends of the propagation path of SAW of IDT electrode 3b. As for such SAW component 2a and 2b, each direction of an electrode finger of the IDT electrodes 3a and 3b is mutually made un-parallel.

[0013] Thus, if the direction of an electrode finger is made un-parallel, it will be thought that a gap of center frequency becomes small according to the following operations.

[0014] That is, although IDT electrode 3of SAW component 2a produced to the 1st time a reflects and the 2nd ultraviolet radiation for exposure is scattered about by it in case the 2nd SAW component (for example, SAW component 2b)

is produced, the main directions of the reflection and dispersion are presumed to be a perpendicular direction to the direction of an electrode finger of IDT electrode 3a (longitudinal direction of an electrode finger). For example, the direction of an electrode finger is parallel, and when SAW component 2a and 2b have lapped mostly, the reflected light and the scattered light by IDT electrode 3a carry out incidence in the line breadth direction of the electrode finger of IDT electrode 3b, and affect the line breadth of a direct electrode finger. Then, if the direction of an electrode finger is made un-parallel, according to the angle theta to make, the reinforcement of the ultraviolet radiation which carries out incidence in the line breadth direction of the electrode finger of IDT electrode 3b decreases, line breadth precision will stop being able to deteriorate easily and, as a result, a gap of center frequency will be considered to become small.

[0015] Drawing 2 shows other operation gestalten of this invention, and is the perspective view of the basic configuration of SAW equipment Da. The piezo-electric substrate with which 10 consists of a lithium tantalate (LiTaO3) single crystal of 36 degreeY cut-X propagation etc. in this drawing, Two SAW components with which 20a and 20b were prepared in front flesh-side both sides of the piezo-electric substrate 1, respectively, An IDT electrode, the reflector with which 30a and 30b were prepared in 40a, and 40a was prepared in the both ends of the propagation path of SAW of IDT electrode 30a, and 40b and 40b are the reflectors prepared in the both ends of the propagation path of SAW of IDT electrode 30b. As for these SAW components 20a and 20b, the electrode finger of the IDT electrodes 30a and 30b is aslant formed to the bus bar.

[0016] Generally, since SAW is perpendicularly spread to an electrode finger, if the tilt angle of the electrode finger to a bus bar is too large, the propagation path of SAW will shift from the electrode finger of an IDT electrode 30a edge. Therefore, the tilt angle to a bus bar is a maximum of about 30 degrees, and when it is larger than 30 degrees, the expected property as a resonator and a filter is difficult to get [a tilt angle].

[0017] Therefore, angle thetaa which the direction of an electrode finger of SAW

component 20a and the direction of an electrode finger of SAW component 20b make is good to consider as 0 degree<thetaa<=60 degree. About 5 degree<thetaa<=45 degree is good more preferably. If larger [when smaller than 5 degrees, the effectiveness of this invention is difficult to get, and] than 45 degrees, the resonance effectiveness of SAW will fall and loss will tend to increase.

[0018] and two or more drawing 3 is the graphs which produced, expressed the gap of the center frequency of those passbands with 3sigma (sigma: standard deviation) of an axis of ordinate, and set the axis of abscissa to theta every about the SAW equipment D to which the angle theta which uses a piezo-electric substrate as the lithium tantalate single crystal of 36 degreeY cut-X propagation about the thing of drawing 1 , and the direction of an electrode finger makes was variously looked like [equipment], and was changed. As shown in this drawing, 3sigma (sigma: standard deviation) is [theta] small rapidly bordering on about 30 degrees, theta is about 150 degrees or less similarly, and 3sigma becomes small rapidly. Therefore, 30 degrees <= theta<=150 degrees are suitable.

[0019] Furthermore, generally, when a piezo-electric substrate is the lithium tantalate single crystal of 36 degreeY cut-X propagation, since the inclination field of **4MHz and a passband edge is 4MHz, it is good [spacing of a passband and a rejection band region / the shift amount of the passband edge by 20MHz and the temperature change (operational temperature range: -30 degrees C - 80 degrees C)] to suppress dispersion in center frequency below to 20-4x2-4=8MHz. Therefore, in drawing 2 , it became clear that the field where dispersion in center frequency becomes below 8MHz was 36.3 degrees <= theta<=143.7 degrees.

[0020] Although SAW component 2a of this invention and 2b may be the so-called SAW filters of the filter with which frequency characteristics, such as center frequency and pass band width, differ, respectively, and a dual mode, even if they are the thing of the same frequency characteristics, they are not cared about. Moreover, two or more same SAW components as one principal plane may be prepared, for example, ladder mold SAW filters, such as a 2.5 step

pi mold, a 2.5 step T mold, and a three-step mold, may be constituted.

[0021] When the SAW equipment D of this invention is the SAW filter of the above-mentioned dual mode, SAW component 2a and IDT electrode 3a of 2b differ in an electrode finger pitch and electrode digital-furrow width of face from IDT electrode 3b, respectively, and Reflectors 4a and 4a differ from Reflectors 4b and 4b similarly. Such IDT electrode 3a, IDT electrode 3b, Reflectors 4a and 4a, and Reflectors 4b and 4b are formed of a process including the removal process of the unnecessary resist by the film formation process of the electric conduction film by the resist spreading process of a positive type (type which dissolves by exposure), or a negative mold (type which does not dissolve by exposure), a photolithography process, the vacuum deposition method, the sputtering method, the CVD method, the applying method, etc., the lift-off method, the etching method, etc. and the unnecessary electric conduction film.

[0022] For example, it is produced by following process (1) - (6).

[0023] (1) Wash the piezo-electric substrate 1 of the lithium tantalate single crystal of the 36 degreeY cut-X propagation which ground the front face, apply a resist to the one principal plane (front face) by about 1.0-micrometer thickness, and make it dry at 90 degrees C.

[0024] (2) Use the photo mask which forms electrode line breadth, such as IDT electrode 3a, by about 1 micrometer, and they are the wavelength of about 225nm, and output 25.2 mW/cm2. Ultraviolet radiation performs adhesion exposure for about 4 seconds, and it is made to dry at 110 degrees C, and it is immersed in a developer, negatives are developed for 90 seconds, and a rinse is carried out with pure water.

[0025] (3) Form aluminum for IDT electrode 3a and reflector 4a, and 4a with vacuum evaporation technique, and carry out lift off of the unnecessary section of aluminum to a resist with resist exfoliation liquid.

[0026] (4) Apply a resist to the principal plane (rear face) of another side of the piezo-electric substrate 1 by about 0.5-micrometer thickness, and make it dry at 90 degrees C.

[0027] (5) Use the photo mask which forms electrode line breadth, such as IDT electrode 3b, by about 0.5 micrometers, and they are the wavelength of about 225nm, and output 25.2 mW/cm2. Ultraviolet radiation performs adhesion exposure for about 1.5 seconds, and it is made to dry at 110 degrees C, and it is immersed in a developer, negatives are developed for 90 seconds, and a rinse is carried out with pure water.

[0028] (6) Form aluminum for IDT electrode 3b and reflector 4b, and 4b with vacuum evaporation technique, and carry out lift off of the unnecessary section of aluminum to a resist with resist exfoliation liquid.

[0029] Thus, SAW component 2b with a line breadth [of the electrode finger of IDT electrode 3b] of 0.5 micrometers is formed in the front-face side of the piezo-electric substrate 1 at a with a line breadth [of the electrode finger of IDT electrode 3a] of 1 micrometer SAW component 2a and rear-face side.

[0030] In this invention, it is desirable to put a protective coat 500A or less all over front flesh-side both sides of the piezo-electric substrate 1 in which SAW component 2a which uses abundantly the IDT electrodes 3a and 3b by which thinning was carried out, and 2b were formed. By preparing a protective coat, effectiveness like the following (1) - (4) is acquired.

[0031] (1) Conventionally, although the resist turned pattern NINGU up and membranes were formed so that a protective coat might be formed for example, except for a pad electrode, and the unnecessary part was removed by the following **** etch method or the lift off method, at the time of the developer immersion in this pattern NINGU process, aluminum alloys for pad electrodes (an aluminum-Cu system, an aluminum-Ti system, aluminum-Si system, etc.) are etch with a developer, and prevent having cause degradation of frequency characteristics, and the fall of dependability.

[0032] (2) Prevent that aluminum of a pad electrode began to melt into water according to the local battery effectiveness, and degradation of frequency characteristics and the fall of dependability had arisen at the time of the pure-water rinse after the development in said pattern NINGU process.

[0033] (3) In case the wafer for piezo-electric substrate 1 is cut by the dicing method, aluminum begins to melt by contacting the pad electrode with which cooling water is not covered by the protective coat, and it can prevent the adhesion reinforcement of wire bond having fallen.

[0034] (4) According to the pyroelectric effect of the piezo-electric substrate 1, discharge arises between the electrode fingers of the IDT electrodes 3a and 3b and Reflectors 4a, 4a, 4b, and 4b at the time of heat treatment of the desiccation process after resist spreading in a pattern NINGU process, a wire-bonding process, a packaging process, etc., and control and prevent at it that an electrode finger is damaged.

[0035] Said protective coats are insulating things, such as SiO2, SiO, Cr-SiO2, Cr-SiO, and SiN, or the semi-conductive (half-conductivity) thing whose resistance of the direction of the film (direction parallel to the film) is about 109-1013ohms, and are the oxide of Si, Ta, Mo, germanium, NiCr, NiCr-Si, and Ta or a nitride, the oxide of Mo or a nitride, the oxide of germanium, or a nitride. 109 Between electrode fingers becomes easy to short-circuit under by omega, and the counteraction of a charge falls in 1013-ohm **. Said semi-conductive protective coat can reduce the incidence rate of discharge to about 30% - about 50% as compared with an insulating thing. This is because a semi-conductive protective coat tends to ease the density-of-electric-charge difference between electrode fingers. Moreover, the electric resistance in a pad electrode becomes small, and degradation of a filter shape is smaller than an insulating thing. Such a protective coat is formed by the thin film forming methods, such as well-known vacuum deposition, the sputtering method, and a CVD method.

[0036] It becomes difficult for the thickness of a protective coat to carry out direct bonding of the wire to a pad electrode, if 500A or less is good and exceeds 500A, consequently the adhesion reinforcement of the wire after bonding falls. Moreover, the electric resistance of a bonding area becomes large and frequency characteristics, such as a filter shape, deteriorate. More preferably, 25-500A is good and the effectiveness as a protective coat is almost lost by less than 25A.

[0037] Moreover, in one principal plane of the piezo-electric substrate 1, it is more desirable to form the electric conduction film for the SAW component of a piece, a circuit pattern, and the pad electrodes for external derivation in 25% or more of the area of said one principal plane at least. By this configuration, the area of the electric conduction film with the early rate which captures the charge which floated in air becomes large, and neutralizes the charge on the electric conduction film and the piezo-electric substrate 1 early.

[0038] In this invention, it consists of aluminum or an aluminum alloy (an aluminum-Cu system, an aluminum-Ti system, aluminum-Si system, etc.), and aluminum and an aluminum-Cu system alloy have high excitation effectiveness, and since ingredient cost is low, the electric conduction film for SAW component 2a, the IDT electrodes 3a and 3b of 2b, Reflectors 4a and 4a and reflector 4b, and 4b has them. [especially desirable effectiveness] Moreover, said electric conduction film is formed by the thin film forming methods, such as vacuum deposition, the sputtering method, a CVD method, or the applying method.

[0039] and the electrode finger of the IDT electrodes 3a and 3b -- 50 to about 200 and electrode digital-furrow width of face are suitable for a logarithm, when about 0.1-10.0 micrometers and electrode finger spacing acquire a property expected [as a resonator or a filter] in about 0.1-10.0 micrometers and electrode finger aperture width (crossover width of face) setting thickness of about 10-100 micrometers and the IDT electrodes 3a and 3b to about 0.2-0.5 micrometers. Moreover, if piezoelectric material, such as a zinc oxide and an aluminum oxide, is formed between the electrode fingers of the IDT electrodes 3a and 3b, the resonance effectiveness of SAW improves and is suitable.

[0040] As a piezo-electric substrate 1 for the SAW equipments D, it is LiTaO3 of 36 degreeY cut-X propagation. LiNbO3 of a single crystal and 64 degreeY cut-X propagation LiB 4O7 of a single crystal and 45-degreeX cut-Z propagation Since [that an electromechanical coupling coefficient is / a single crystal etc. / large and] the group delay temperature coefficient is small, it is desirable. The thickness of the piezo-electric substrate 1 has about 0.3-0.5 goodmm, a piezo-

electric substrate becomes weak in less than 0.3mm, and ingredient cost becomes large in 0.5mm **.

[0041] In this way, in the 2nd photolithography process for making small a gap of the center frequency of each SAW equipment D, and desired uniform frequency characteristics and a filter shape being obtained, and forming an IDT electrode, even if the IDT electrode formed first reflects and the ultraviolet rays for exposure etc. are scattered about with it, this invention cannot be influenced [the] easily and has the operation effectiveness that the line breadth precision of patterning improves compared with the former as a result.

[0042] In addition, this invention is not limited to the above-mentioned operation gestalt, and modification various by within the limits which does not deviate from the summary of this invention does not interfere at all.

[0043]

[Example] The example of this invention is explained below.

[0044] (Example 1) It is the following, and the SAW equipment D of drawing 1 was made and produced. LiTaO3 of the 36 degreeY cut-X propagation by which both the principal plane was ground by the mirror plane as a piezo-electric substrate 1 SAW component 2a and 2b were formed in two principal planes, respectively by enforcing a process including a resist spreading process, a photolithography process, a vacuum deposition process, and a lift-off process for every principal plane using a crystal.

[0045] Specifically, it produced according to the process of the following (1) - (10).

[0046] (1) The resist of a positive type was applied to the front face (one principal plane) of the washed wafer for piezo-electric substrate 1 by about 1.0 micrometers of thickness, and it was dried at 90 degrees C.

[0047] (2) Use the photo mask by which patterning was carried out so that electrode digital-furrow width of face may be set to about 1.0 micrometers, and it is output 25.2 mW/cm2 at the wavelength of about 225nm. Ultraviolet rays performed adhesion exposure for about 4 seconds, and it was made to dry at 110 degrees C.

[0048] (3) It was immersed in the developer for 90 seconds, the resist of the exposure section was dissolved, the rinse was carried out with pure water, and the positive pattern of much SAW component 2a was formed in the resist film.
[0049] (4) The electric conduction film for SAW component 2a, a circuit pattern, and pad electrodes (aluminum-Cu alloy) was formed with vacuum evaporation technique by the thickness of about 3500A, and lift off of the unnecessary electric conduction film was carried out to the unnecessary resist with resist exfoliation liquid.
[0050] (5) The resist of a positive type was applied to the rear face (principal plane of another side) of a wafer by about 0.5 micrometers of thickness, and it was dried at 90 degrees C.
[0051] (6) Use the photo mask by which patterning was carried out so that electrode digital-furrow width of face may be set to about 0.5 micrometers, and it is output 25.2 mW/cm2 at the wavelength of about 225nm. Ultraviolet rays performed adhesion exposure for about 1.5 seconds, and it was made to dry at 110 degrees C.
[0052] (7) It was immersed in the developer for 90 seconds, the resist of the exposure section was dissolved, the rinse was carried out with pure water, and the positive pattern of much SAW component 2bs was formed in the resist film.
[0053] (8) The electric conduction film for SAW component 2b, a circuit pattern, and pad electrodes (aluminum-Cu alloy) was formed with vacuum evaporation technique by the thickness of about 3500A, and lift off of the unnecessary electric conduction film was carried out to the unnecessary resist with resist exfoliation liquid.
[0054] (9) the dicing method using the cooling water of about [specific resistance 10-20M-omegacm] pure water -- a wafer -- every -- it cut for every SAW equipment D.
[0055] (10) Each SAW equipment D was mounted in the package using the adhesives which consist of thermosetting resin, and wire bonding was performed.
[0056] Thus, SAW component 2a whose electrode digital-furrow width of face is

about 1.0 micrometers, respectively, and SAW component 2b whose electrode digital-furrow width of face is about 0.5 micrometers were produced to front flesh-side both sides of the piezo-electric substrate 1.

[0057] In this example, when the angle theta of the direction of an electrode finger of SAW component 2a and the direction of an electrode finger of SAW component 2b to make was made into 0 degree, 30 degrees, 60 degrees, 90 degrees, 120 degrees, and 150 degrees, it produced such SAW equipment D 20 pieces at a time respectively and gap 3sigma of such center frequency be measured, they were 9.9MHz, 8.6MHz, 5.4MHz, 4.3MHz, 5.8MHz and 8.4MHz, respectively.

[0058] moreover, in this example, the ultraviolet rays for exposure are reflected and scattered about at the time of SAW component 2b production with the electric conduction film for SAW component 2a formed first -- having -- being hard -- consequently, the former -- the line breadth of the electrode finger of SAW component 2b -- about 1.0 -- what was the precision beyond micrometer**0.15micrometer -- this example (theta= 60 degrees) -- about 1.0 -- it has been improved with micrometer**0.09micrometer.

[0059] (Example 2) After the above-mentioned process (8), it is SiO2. SAW equipment D was produced like the example 1 except having put the protective coat all over the wafer by the thickness of 250A by the sputtering method. Although the filter shape was measured before and after protective coat covering, it is changeless and the adhesion reinforcement of a wire was also over the desired value (5g pile) as a product with all products.

[0060] (Example 3) After the above-mentioned process (8), SAW equipment D was produced like the example 1 except having put the protective coat of Si all over the wafer by the thickness of 250A by the sputtering method. Although the filter shape was measured before and after protective coat covering, it is changeless and the adhesion reinforcement of a wire was also over the desired value (5g pile) as a product with all products.

[0061] (Example of a comparison) After the above-mentioned process (8), SAW

equipment D was produced like the example 1 except having put the protective coat of Si all over the wafer by the thickness of 600A by the sputtering method. It was changeless although the filter shape was measured before and after protective coat covering. However, the adhesion reinforcement of a wire was less than the desired value (5g pile) as a product, and about 10% of all products became a defective.

[0062]

[Effect of the Invention] This invention is SAW equipment which comes respectively to prepare the SAW component which has an IDT electrode in front flesh-side both sides of one piezo-electric substrate, when the direction of an electrode finger of the IDT electrode of front flesh-side both sides is not parallel, makes a gap of the center frequency of SAW equipment small, and has the operation effectiveness that desired uniform frequency characteristics and a filter shape are obtained. Moreover, in the 2nd photolithography process for forming an IDT electrode, even if the IDT electrode formed first reflects and the ultraviolet rays for exposure etc. are scattered about with it, it is [the] hard to be influenced and, as a result, the line breadth precision of patterning improves conventionally.

[0063] By preparing a protective coat at moreover, the time of the developer immersion in the pattern NINGU process of a resist aluminum of a pad electrode is etched with a developer, or aluminum of a pad electrode begins to melt into water according to the local battery effectiveness at the time of the pure-water rinse after development, Furthermore, since aluminum begins to melt by contacting the pad electrode with which cooling water is not covered by the protective coat in case the wafer for piezo-electric substrates is cut by the dicing method, problems, such as degradation of frequency characteristics, a fall of dependability, and a fall of the adhesion reinforcement of wire bond, are solvable.

[0064] Furthermore, by said protective coat, discharge arises between the electrode fingers of an IDT electrode and a reflector according to the pyroelectric effect of a piezo-electric substrate at the time of heat treatment of the pattern NINGU process of a resist, a packaging process, a wire-bonding process, etc.,

and it controls and prevents at it that an electrode finger is damaged. Moreover, a semi-conductive protective coat has the large effectiveness of discharge control. Or it can prevent that a conductive foreign matter invades into IDT inter-electrode, and between electrode fingers short-circuits by the protective coat, consequently the manufacture yield improves, and dependability also becomes high.

[Translation done.]

* NOTICES *

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the perspective view of the SAW equipment D of this invention.
[Drawing 2] Other operation gestalten of this invention are shown and it is the perspective view of SAW equipment Da.
[Drawing 3] In the SAW equipment D of this invention, it is the graph which shows the relation of angle theta and the gap of center frequency which the direction of an electrode finger of each SAW component makes.
[Drawing 4] Conventional SAW equipment D1 It is shown and (a) is SAW equipment D1. A perspective view and (b) are the sectional views in the A-A line of (a).

[Drawing 5] Degradation of the line breadth precision of conventional SAW equipment is explained, and it is the fragmentary sectional view of the piezo-electric substrate in the 2nd photolithography process.

[Description of Notations]

1: A piezo-electric substrate

2a: SAW component

2b: SAW component

3a, 3 b:IDT electrodes

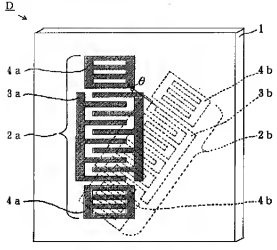
4a, 4b: Reflector

[Translation done.]

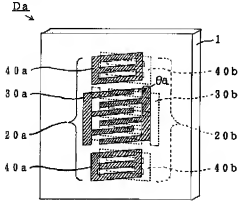
* NOTICES *

DRAWINGS

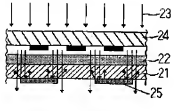
[Drawing 1]



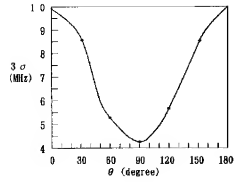
[Drawing 2]



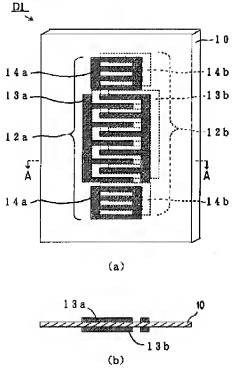
[Drawing 5]



[Drawing 3]



[Drawing 4]



[Translation done.]